A Proposed Revision of the:

GUIDELINES RESPECTING PHYSICAL ENVIRONMENTAL PROGRAMS DURING PETROLEUM DRILLING AND PRODUCTION ACTIVITIES ON FRONTIER LANDS

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DRAFT

National Energy Board
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ABBREVIATIONS AND DEFINITIONS

The terms and abbreviations listed in Table i-1 are used in this document.

Table i -1 - Terms and Abbreviations

Terminology / Abbreviation	Description
Aviation Weather Observer	Qualified individual tasked with aviation weather observing duties and who has a detailed practical knowledge of and experience in all observing standards and techniques related to aviation weather observing, and is conversant with relevant WMO standards and guidelines and who understands the data requirements for forecasting and climatological purposes. Aviation weather observer qualification/certification is a responsibility of the Operator.
Aviation Weather Observing	Aviation weather observing procedure.
Aviation Weather Reporting	Aviation weather reporting procedure.
BIO	Bedford Institute of Oceanography
BUFR	Binary Universal Form for the Representation of Meteorological data. A generic binary (or digital) format for representing environmental data (not just meteorological data). METAR and MANMAR reports, for example, can be stored and distributed in BUFR format.
CAPP	Canadian Association of Petroleum Producers
CAR	Canadian Aviation Regulation
CCG	Canadian Coast Guard
CIS	Canadian Ice Service
CMC	Canadian Meteorological Centre
CNOPB	Canada-Newfoundland Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
CTD	Conductivity - Temperature - Depth. Profile data used to determine seawater properties, e.g. density, temperature, salinity.
Drilling Regulations	*Canada Oil and Gas Drilling Regulations* *Newfoundland Offshore Petroleum Drilling Regulations* *Nova Scotia Offshore Petroleum Drilling Regulations*
Equipment List	A preliminary list of equipment suitable for offshore use.
FTP	File Transfer Protocol. An internet / network file transfer protocol.
GFA	A graphical aviation forecast. This forecast is provided by MSC for the offshore.
GRIB	GRIdded Binary formats for representing environmental field data (i.e. analysis and forecast data arranged in a regular spatial grid).
GTS	Global Transmission System
Guidelines	This document

Terminology / Abbreviation	**Description**
ICAO	International Civil Aviation Organization
Ice Forecasting Contractor	Contractor responsible for Installation sea ice and iceberg forecasting.
Ice Management Contractor	Contractor responsible for Installation ice management and observing program.
Ice Management Plan	A description prepared by the Operator that describes the offshore Ice Management Program. Submitted by the Operator to the Regulator.
Ice Management Program	Ice management activities for an Installation.
ICE	The Shipboard Ice Code. A formatted ice observation defined in *MANMAR*. A format for marine weather, sea state and ice reports.
ICEBERG	The Iceberg Message. A formatted iceberg observation defined in *MANICE*. This code was developed by MSC and IIP and supplements the WMO ice code.
Ice Observer	Qualified individual tasked with ice observing and management duties.
Ice Observing	Ice observing procedure.
Ice Reporting	Ice reporting procedure.
IIP	U.S. Coast Guard International Ice Patrol
Industry	The offshore petroleum industry.
Installation	The offshore exploration or production installation (e.g. rig, drillship, platform, FPSO). May be a group of installations.
Installation Regulations	*Canada Oil and Gas Installation Regulations* *Newfoundland Offshore Petroleum Installation Regulations* *Nova Scotia Offshore Petroleum Installation Regulations*
MANAIR	Manual of Standards and Procedures for Aviation Weather Forecasts
MANICE	Manual of Ice Observing. Also referred to in the context of an ice observing standard.
MANMAR	Manual of Marine Observations. Also referred to in the context of a marine weather and sea state observing standard.
MANMAR	A format for marine weather and sea state reports (either the MANMAR "Selected Ship" format or the more general SYNOPTIC SHIP format).
MANOBS	Manual of Surface Weather Observations. Also referred to in the context of an (land-based) aviation observing standard.
Marine Weather Observer	Qualified individual who is tasked with marine weather and sea state observing duties and who has a detailed practical knowledge of and experience in all observing standards and techniques related to marine weather observing, and is conversant with relevant WMO standards and guidelines and who understands the data requirements for forecasting and climatological purposes. Marine weather observer qualification/certification is a responsibility of the Operator.
Marine Weather and Sea State Observing	Marine weather and sea state observing procedure.
Marine Weather and Sea State Reporting	Marine weather and sea state reporting procedure.

Terminology / Abbreviation	**Description**
MEDS	Marine Environmental Data Service
Metadata	Metadata or "data about data" describe the content, quality, condition, and other characteristics of data.
METAR	A character-based format for an hourly aviation weather observation. Also referred to as the aviation weather report.
Meteorologist	A qualified individual responsible for weather forecasting. Meteorologist minimum qualifications are described in these *Guidelines*.
Meteorology Program	Meteorological monitoring activities for an Installation.
Monitoring Program	Weather, sea state and ice measurement, observation and reporting programs for an Installation. Also all management of these programs.
Monitoring Program Management	Procedure for management of a Monitoring Program.
MSC	Meteorological Service of Canada
NAVCAN	NAV CANADA, the Canadian provider of civil air navigation services.
NEB	National Energy Board
NWS	National Weather Service (of the United States)
Oceanographic Contractor	Contractor responsible for providing, installing and maintaining oceanographic equipment.
Oceanographic Observing	Oceanographic observing procedure.
Oceanographic Program	Ocean monitoring activities for an Installation.
Oceanographic Reporting	Oceanographic reporting procedure.
Operator	The Operator of the offshore installation.
PMO	MSC Port Meteorological Officer.
Policies & Procedures	Observing and Reporting policies and procedures developed for the Offshore.
Program Description	An outline prepared by the Operator that describes the offshore monitoring program. Submitted by the Operator to the Regulator.
Production and Conservation Regulations	*Canada Oil and Gas Production and Conservation Regulations* *Newfoundland Offshore Area Petroleum Production and Conservation Regulations* *Nova Scotia Offshore Area Petroleum Production and Conservation Regulations*
Regulations	Legislation applicable to environmental programs for the Offshore Petroleum industry (listed in Section 1 of these *Guidelines*).
Regulator	CNOPB, CNSOPB, NEB and/or Transport Canada as appropriate
SAWRS	Supplementary Aviation Weather Observations (an obsolete aviation observing standard formerly used in the Offshore)
SPECI	A character-based format for a special aviation weather observation.
TAF	Terminal Aviation Forecast. A site-specific aviation forecast used for flight planning. These are not mandated for the offshore.
TC	Transport Canada
WAN	Wide Area Network

Terminology / Abbreviation	**Description**
WAVEOB	A formatted spectral wave data report.
Weather Forecasting Contractor	Contractor responsible for Installation weather and sea state forecasting program.
Weather Observer Instructor	Qualified individual with considerable practical experience aviation and marine observing, references to that competence plus experience and training in instructional techniques.
Weather Observing Contractor	Contractor responsible for Installation weather and sea state observing program.
WinIDE	Windows Interactive Data Entry. A program available from MSC that performs weather observation entry, quality control, and communications.
WMO	World Meteorological Organization

1.0 INTRODUCTION

These *Guidelines* are intended to clarify requirements for the Operators of petroleum drilling or production installations (the Installation) concerning the observing, forecasting and reporting of physical environmental data which appear in the following federal, Nova Scotia, and Newfoundland Frontier Lands Regulations (the *Regulations*):

- *Canada Oil and Gas Installation Regulations*
- *Canada Oil and Gas Drilling Regulations*
- *Canada Oil and Gas Production and Conservation Regulations*
- *Newfoundland Offshore Petroleum Installation Regulations*
- *Newfoundland Offshore Petroleum Drilling Regulations*
- *Newfoundland Offshore Area Petroleum Production and Conservation Regulations*
- *Nova Scotia Offshore Petroleum Installation Regulations*
- *Nova Scotia Offshore Petroleum Drilling Regulations*
- *Nova Scotia Offshore Area Petroleum Production and Conservation Regulations*
- *Transport Canada Air Regulations and Aeronautics Act*

The primary objective of the physical environmental monitoring programs described in the *Guidelines* is to ensure that appropriate weather, oceanographic, and ice information is available during an exploratory drilling or production program to support the safe and prudent conduct of operations and emergency response. Information collected during the program is also necessary to establish a sound and reliable data base, which in turn will assist Operators in planning future operations in the area, and the Regulators in performing their duties relating to environmental assessment, review of design and operating criteria, and review and approval of applications and contingency plans.

These *Guidelines* supersede the previous (1994) version. Previous versions of these *Guidelines* have been modified as a result of field experience, the quantity and quality of data available for an area, and advances in technology. The Regulator continues to be interested in new developments in any of these areas, and invites suggestions for future improvements to the *Guidelines* which may be suggested by these developments. The present edition was developed through a consultative process including representation from Industry, government departments, consultants, and the International Ice Patrol (IIP). The Regulator encourages ongoing consultation.

1.1 Environmental Monitoring Program Development

The suggested approach of development of a Monitoring Program by an Operator, for a specific Installation, is depicted in Figure 1-1. Development of an offshore Monitoring Program using the suggested approach should facilitate the Operator's fulfillment of all regulatory requirements.

Figure 1-1 Suggested Approach to Program Development

The Operator may elect to meet regulatory requirements and these *Guidelines* using another program.

1.2 Environmental Monitoring Program Description

A description (the *Program Description*) of the weather, oceanographic, and ice programs, where appropriate, must be submitted either to the National Energy Board (NEB), to the Canada-Newfoundland Offshore Petroleum Board (CNOPB) in the Newfoundland Offshore Area, or to the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) in the Nova Scotia Offshore Area. For brevity, the generic term "Regulator" will be used in the remainder of this document. The description should accompany the application for Drilling Program Authorization, in the case of exploratory drilling, and the application for Production Operations Authorization in the case of production. Any changes to these programs, associated with a change in offshore Installation or location, should be noted in the drilling or production application. The Operators are encouraged to consult with the Regulator about the program as soon as possible, where such changes are contemplated.

The description should include, at least, the following information:

- An outline of the physical environment monitoring team, with roles and responsibilities identified.
- An outline of program management.
- An outline of the meteorology, oceanography and ice monitoring programs.
- An outline of the meteorology, oceanography and ice forecasting programs.
- An outline of any forecast verification programs (Appendix E)
- The names, addresses, and description of the roles of any contractors involved in the program.
- A description of any unusual or non-standard features of the program.
- A description of any departures from these *Guidelines*, with justification.
- A description of any departures from the *Equipment List* (Appendix C), with justification.

If operators wish to alter the spatial and temporal collection of data within their areas of operation, including multi-operator equipment/data sharing, the program description should include justification for the proposed changes. The Regulator will review such proposals on a case-by-case basis.

The Operator's *Program Description* will include, at a minimum, a Program description containing a general (i.e. "high-level") summary of the following generic procedures:

Table 1-1 Monitoring Program Management

Monitoring Program Management	
Meteorology	▪ Aviation Weather Observing ▪ Marine Weather and Sea State Observing ▪ Aviation Weather Reporting ▪ Marine Weather and Sea State Reporting
Oceanographic	▪ Oceanographic Observing ▪ Oceanographic Reporting
Ice Management	▪ Ice Observing ▪ Ice Reporting

2.0 APPLICABLE REGULATION(S)/LEGISLATION

These *Guidelines* are governed by set regulations and legislation, which serve to form the basis of an offshore environmental program.

2.1 Meteorology

The following documents provide a basis for an aviation weather and marine weather and sea state-observing program at an Installation.

- *CAR 804.1(c) MANOBS - Manual of Surface Weather Observations* [1].
- *MANMAR- Manual of Marine Weather Observing* [5].
- *Annex 3 to The Convention on International Civil Aviation* [8].
- *Guide to the Provision of Meteorological Service for International Helicopter Operations* [19].

2.2 Oceanography

The results of the measurement programs are of most use when the data that are collected are consistent and complementary with those collected by other Operators and by government agencies operating in the same areas. Therefore, the standards of measurement and the documentation set out in these *Guidelines* should be incorporated in the design of the Operator's program.

2.3 Ice Management

A requirement of the *Production and Conservation Regulations*, the Operator shall prepare, as appropriate, an *Ice Management Plan* which shall be submitted for approval to the Regulator as part of the Authority to Drill a Well (ADW). Refer to Appendix F.

3.0 PROGRAM DESCRIPTION

3.1 Observations

The Operator is required, pursuant to the Regulations, to take meteorological, oceanographic and ice measurements during exploratory drilling and production programs on Frontier Lands. Unless otherwise agreed to IN WRITING by the Regulator, observations are to be taken in accordance with this document.

The Regulator, after consultation with the Operator and the appropriate government agencies, may exempt the Operator from these standards and procedures deemed not to be applicable to offshore operations.

Regulations require that the following environmental parameters be observed and recorded daily:

a) The presence of any ice floes or icebergs and their movement;
b) At least once every three hours:
   i) Wind direction and speed,
   ii) Wave height and period (direction optional),
   iii) Swell direction, height and period,
   iv) Current direction and speed,
   v) Barometric pressure,
   vi) Air temperature,
   vii) Sea water temperature,
   viii) Visibility;
c) The precipitation amount measured in the previous 24-hour period; and
d) The pitch, roll and heave of floating installations.
e) Ocean currents.

Vessel response information about the pitch, roll and heave of the helideck is required to land a helicopter on a floating installation. The above list is further specified in this document.

3.2 Meteorology and Oceanography Observing and Reporting

Meteorological observing policies and procedures have been developed for the offshore, through a joint Industry and Government consultation process. The following subsections outline the main features of offshore aviation and marine weather observing.

3.2.1 Parameters to be Observed

Parameters to be observed and/or reported are listed in Table 3-1.

Table 3-1 - Aviation and Marine Observing and Reporting Parameters

Parameter	Reported	Notes
Wind direction	Aviation / Marine	From which the wind is blowing, clockwise from true north in degrees (meteorological convention). 10 minute average for marine, 2 minute average for aviation
Wind speed	Aviation / Marine	10 minute average for marine, 2 minute average for aviation Gusts and squalls are reported for aviation but not for marine.
Mean sea level pressure	Aviation / Marine	Derived quantity
Pressure tendency	Aviation / Marine	3-hour pressure difference
Pressure tendency characteristic	Marine	MSL pressure time series trace required to determine this characteristic
Altimeter setting	Aviation	Derived quantity
Air temperature	Aviation / Marine	Required for mean sea level pressure and altimeter calculations
Air humidity (dew point and wet bulb temperature)	Aviation / Marine	Required for mean sea level pressure and altimeter calculations
Horizontal visibility	Aviation / Marine	
Cloud and ceiling heights	Aviation / Marine	
Cloud layer amounts	Aviation / Marine	
Cloud layer opacities	Aviation	
Cloud types	Aviation / Marine	
Vertical visibility	Aviation / Marine	
Precipitation intensity	Aviation / Marine	
Precipitation amount	Marine	May be required for climatological purposes at some Installations
Current weather types	Aviation / Marine	
Past weather types	Marine	
Height of anemometer	Aviation / Marine	Required to relate wind measurements to standard 10 metre height
Height of barometer	Aviation / Marine	Required for mean sea level pressure and altimeter calculations
Reference height of station	Aviation / Marine	Required for mean sea level pressure and altimeter calculations
Heave, pitch and roll	Aviation	Required for floating installations
Sea wave significant height	Marine	
Sea wave direction	Marine	
Sea wave average period	Marine	
Swell direction(s)	Marine	
Swell significant height(s)	Marine	
Swell average period(s)	Marine	
Maximum combined seas	Aviation/Marine	Included as a "remark" in the Aviation report
Wave spectrum peak period	Marine	
Sea surface temperature	Aviation / Marine	Included as a "remark" in the Aviation report
Ice accretion rate	Marine	
Ice accretion amount	Marine	
Ice / iceberg conditions	Marine	Basic information on ice / icebergs is required for marine observation

Aviation Observing

Aviation observing shall be performed according to a standard[1] recognized by Transport Canada (TC) as suitable for the Canadian offshore. The standard shall include appropriate:

- Aviation observing program management;
- Quality assurance;
- Specification, calibration and maintenance of equipment;
- Observer-use of equipment;
- Aviation observing procedures;
- Reporting procedures;
- Data archiving procedures;
- Training of observers; and,
- Testing and qualification of observers.

Marine Observing

Marine observing shall be performed in a manner suitable for the Canadian offshore. Marine observing shall include appropriate:

- Marine weather monitoring program management;
- Quality assurance;
- Specification, calibration and maintenance of equipment;
- Observer-use of equipment;
- Weather, sea state and ice observing procedures;
- Reporting procedures;
- Data archiving procedures; and
- Training of observers.

3.2.2 Oceanographic

An oceanographic measurement program should be designed to meet the overall objectives of the monitoring program. In most instances the oceanographic monitoring measurements described in the following subsections will suffice.

Current Measurements

Ocean currents should be measured, as a minimum, at three levels in the water column i.e. near surface in the anticipated wave zone, mid-depth, and near-bottom near each Installation. Normally, single point moorings are recommended. These may also be, under special circumstances, augmented by vessel mounted ADCP measurements if required by the Operator and approved by the Regulator. Ocean currents will be measured with a view to resolution of oceanographic processes. These will generally include tide and non-tide components and may also include vertical structure. Proposed current measuring programs should be included in the Program Description for approval in accordance with Section 1.2.

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[1] Standards, which clearly define training for observers, will be developed in conjunction with government and industry.

Conductivity Temperature Depth Measurements

Pressure, temperature, and salinity data provide information on identification of water masses and complement water movement data provided by the velocity measurements. The provision of CTD information shall be made available by the Operator as required.
The Operator must ensure that oceanographic equipment is tested periodically to ensure that it would be available for emergency use.

Sea State Measurements

The following measured sea state parameters, as a minimum, shall be measured:

- Significant wave height
- Maximum wave height
- Wave spectrum average period
- Wave spectrum

When the significant wave height exceeds 4 metres or the wind speed is greater than 17.5 metres per second (34 knots), continuous recordings of the wave height should be made.

Water Levels

Water level measurements may be required at some locations. If required, measurements should be made to the specifications set down by the Canadian Hydrographic Service [6] and in this document. The requirements for water level measurements shall be agreed upon with the Regulator.

3.3 Collection Specifications

Collection specifications for meteorological and oceanographic measurements are listed in Appendix B. These specifications apply to sensor data specifically (i.e. not the elements of reports). Measurements required are indicated in Section 6.0.

Averaging and recording intervals, and other required information are provided by the Operator or appropriate contractors, in a document file. A record specification will be included to define the layout of data records; variable and unit's identification, and record format specification. A completed equipment data sheet (see Appendix D) shall be included with all data sets, as a component of the data set documentation.

3.4 Reporting

Several types of physical environmental reports may be issued from, or sent to, an Installation in real-time.

These include:

- Marine weather and sea-state reports (MANMAR-format reports);

- Aviation weather reports (BUFR-format reports);
- Metadata reports
- Ice reports (generally in the ICE format);
- Iceberg reports (generally in the ICEBERG format);
- Wave spectral data reports (generally in the WAVEOB format);

- Site-Specific weather and sea state forecasts;
- Ice forecasts (sea ice and iceberg trajectory); and,
- Aviation terminal forecasts (in TAF format).

Figure 3-1 depicts the flow of information (data management) to and from an Installation, and to information-users. There are a number of general points to be made in reference to this figure:

- There shall be single distribution channels for any report, from an information provider to an information user. The "single-point-of-failure" approach enables rapid tracing in the event of data disruption.
- Quality assurance and control procedures shall be incorporated into all aspects of the reporting process: by the information provider, the information user, and within the data management system.
- Report delivery notification procedures shall be a component of routine operations.
- Report correction procedures shall be implemented for all report distributions.
- Users of reports shall be able to notify data managers of the disruption of report distribution on a 24-hour per day basis.
- Backup systems are required for all critical report distribution procedures.

Figure 3-1 – Real-time Reporting

3.4.1 Marine Weather Reporting

Marine observations will be provided with 24-hours per day coverage. As a minimum manually observed and reported MANMAR observations will be provided every three hours

(with special reports as required). This activity may be replaced by an automated system that will deliver instrument-reported weather and sea state data to shore on the hour, and every 20 minutes during significantly changing weather and sea state conditions.

Marine observations are generally reported in a MANMAR format (see [5]). MANMAR format is an instance (a subset) of the WMO "SYNOPTIC code" (WMO FM 13-IX SHIP code) used in Canada (see [15] or [1]). An Installation may be considered a "selected ship" for the purpose of MANMAR reporting. Marine observations may also be prepared according to the WMO FM 12-IX SHIP format, which enables reporting of measured precipitation and sea state. In these *Guidelines* the term MANMAR refers to both the Canadian MANMAR format and the WMO SYNOPTIC SHIP code, either of which may be used by the Operator. Marine observations may be prepared manually by the Marine Weather Observer, or in an automated fashion directly from sensor inputs. Other formats may be used for Operator-specific applications of marine weather and sea state information.

3.4.2 Aviation Reporting

Aviation observations will be prepared by a qualified Aviation Weather Observer, on an hourly basis, on those days when helicopter flights are scheduled. The aviation observation program will be in operation at least during the period 0800 UTC until the last helicopter has landed on shore. It is recommended that aviation reports be issued either daily from 0800 UTC to 1900 UTC or, ideally, on a 24-hour basis. "Special" and "check" reports will be taken as required. A capability for performing aviation observing will exist at all times on the Installation. There will be at least two individuals capable of providing sufficient meteorological and helideck-condition information to pilots to safely land an emergency helicopter (e.g. a medivac) on the Installation at all times

Aviation reports may be distributed from the Installation in a WMO FM 94 BUFR (Binary Universal Form for the Representation of Meteorological data) format (see [9] and [16]), for distribution to MSC, who convert the BUFR message into a METAR or SPECI report. Other formats may be used for Operator-specific applications of aviation information. The use of *SAWRS*-based aviation observations shall be discontinued for those installations using it. *SAWRS* is an obsolete standard and format.

3.4.3 Metadata Reporting

Metadata report information will be collected by the Weather Forecasting Contractor from various sources including the marine and aviation weather observers and the Operator. Metadata will be delivered to government agencies at the inception of the physical environmental program and whenever changes occur.[2] The reporting structure is outlined in Appendix H.

3.4.4 Oceanographic Data

There are several approaches that an Operator may take in the real-time reporting of oceanographic data. Sea state (i.e. wave height, direction and period) and sea surface

[2] Metadata format is currently under review by MSC and MEDS. (Jan. 2004)

temperature are required components of the marine and aviation weather observation programs.

The Operator is encouraged to collect real-time oceanographic data whenever possible. The recommended format for real-time oceanographic data is the WMO BUFR binary format. Wave spectra data can also be distributed using the WMO WAVEOB character format. Standard international protocols have been developed for the provision of oceanographic data in BUFR format. BUFR observations can be distributed internationally, providing support to operational meteorological and oceanographic forecasting and the WMO World Weather Watch generally. The Operator will benefit through improvements in the skill of operational analysis and forecast products.

3.4.5 Automated MANMAR Reporting

An Operator may elect to report sensor-derived (as opposed to manually recorded) data in a MANMAR reports provided that:

- Automated MANMAR-formatted reports are prepared and distributed in real-time to MSC on an hourly basis.
- Wind, temperature, humidity, and sea state sensors are routinely validated according to suitable quality assurance and control procedures.]
- If equipment problems occur, bad data should be marked appropriately as missing and an updated Metadata report should be sent.
- There is a capability for manual observations to be taken on a 3 hourly basis should automatic reporting systems fail.
- The marine weather observer has the ability to add fields which are not sensor-derived.

Aviation observations must be prepared by a certified aviation weather observer.

3.4.6 Ice Management Observing and Reporting

Sea ice and iceberg observations should be compiled as described in *MANMAR [5], MANICE* [3] and in the Operator's *Ice Management Plan*. Ice observations are essential for Installation safety and operations and for logistics support, and are a necessary source of information for strategic ice services groups, i.e. CIS and IIP.

3.4.6.1 Ice Observers

Installation: observations must be made by a trained observer.

Supply Vessels: under the Safety of Life at Sea (SOLAS) agreement, ships must report all hazards to navigation. Vessel ice reconnaissance is an integral part of ice management.

Aerial Support: helicopter and other aircraft should observe ice conditions, as they are able.

Observers shall report ice for the radar and visual ranges experienced on their respective observation platform, e.g. unit, ship, helicopter.

3.4.6.2 Sea Ice Parameters to be Observed and Reported

The manner in which pack ice information is recorded and reported is detailed as part of *MANICE* [3], *MANMAR* [5], and the Operator's *Ice Management Plan* and is described in Table 3-2.

Table 3-2 – Sea Ice Parameters

Parameter	Comments
Sea ice information:	
Call sign	- Unit or vessel identification, e.g. VOBL
Date-time	- dd/mm/yy hhmm of observation (UTC)
Latitude, longitude	- Degrees and decimal minutes for position of vessel reporting (0.1' accuracy as a minimum) e.g. 5030.2 N 5106.3 W
Ice Edge Positions:	
{range (nm), bearing (°T)}	- Ice edge positions: a set of points delineating the ice edge relative to the observing vessel's position (0.01 nm accuracy)
Egg Code: Ice Concentration, Thickness, Floe Size	
Total concentration Partial concentrations Thicknesses Floe sizes	- Total concentration of sea ice of all types, together with three values, e.g. distinguished 'A', 'B', and 'C', for each of the parameters partial concentration, thickness, and floe size. - Use *MANICE* egg code thickness and floe size codes.
Drift direction (degrees toward, °T)	- Ice floe drift direction, e.g. 160°
Drift speed (knots)	- Ice floe drift speed
Radar range	- The effective radar range at the time of the observation (nm)
Other (as per the Iceberg additional information Table A.7-2): physical management, vessel, environmental, and other information (as available). *The observer should note any additional information as appropriate and note units when there is any chance of confusion.*	
Vessel course	- Ship or aircraft heading (degrees toward)
Vessel speed	- Ship or aircraft speed (knots or mph)
Reconnaissance area	- Description of area of coverage
Sea temperature (°C) Wave height (m)	

Parameter	Comments
Wave period (s)	- Environmental information relevant for sea ice modelling, tactical information relevant for physical management considerations, and potentially other support operations.
Wind speed (kt)	
Wind direction (degrees from)	
Current speed (kt or m/s)	
Current direction (degrees to)	
Sea ice concentration	
Sea ice thickness	

3.4.6.3 Iceberg Parameters to be Observed and Reported

The manner in which iceberg information is recorded and reported is detailed as part of *MANICE* [3], *MANMAR* [5], and the Operator's *Ice Management Plan* and is described in Table 3-3.

Table 3-3 – Iceberg Parameters

Parameter	Comments
Vital iceberg information:	
Call sign	- Unit or vessel identification, e.g. VOBL
Date-time (UTC)	- dd/mm/yy hhmm of observation
Latitude, longitude (degrees and decimal minutes, 0.1' accuracy as a minimum, e.g. 5030.2 N 5106.3 W)	- Position of iceberg target: for some observation reporting, it will be sufficient to report target range and bearing from the observer's location, e.g. on supply vessel
Size	- Use IIP/CIS size classification codes. e.g. LB, BB
Shape	- Use IIP/CIS shape classification codes, e.g. TAB, DOM
Confidence	- Source of observation: radar, visual, or radar+visual
Additional iceberg information (as available):	
Length (m)	- Iceberg dimensions (m)
Width (m)	
Height (m)	
Draft (m)	
Drift direction (degrees toward)	- Iceberg drift direction, e.g. 160°
Drift speed (knots)	- Iceberg drift speed
Length method flag	- An indication of the method used to obtain the iceberg length/width/height measurement, e.g. measured with camera or sextant, estimated, missing
Width method flag	
Height method flag	
Draft method flag	- An indication of the method used to obtain the draft, e.g. measured, estimated, grounded

Parameter	Comments
Radar range (nm)	- The effective radar range at the time of the observation
Other: physical management, vessel, environmental, and other information (as available). The observer should note any additional information as appropriate and note units when there is any chance of confusion.	
Deflection assessment	- An assessment of the probability of successful deflection of this iceberg, e.g. 1-good, 2-fair, 3-poor, 4-impossible
Deflection type	- Deflection method, if iceberg is presently being deflected, e.g. 1-tow, 2-water cannon, 3-prop wash, 4-other (specify)
Deflection heading	- Direction toward which deflection is directed
Vessel course (degrees toward)	- Ship or aircraft heading
Vessel speed (knots or mph)	- Ship or aircraft
Reconnaissance area	- Description of area of coverage
Sea temperature (°C)	- Environmental information relevant for iceberg modelling, tactical information relevant for physical management considerations, and potentially other support operations. - Report additional sea ice details as per Table A.7-1.
Wave height (m)	
Wave period (s)	
Wind speed (kt)	
Wind direction (degrees from)	
Current speed (knot or m/s)	
Current direction (degrees to)	
Sea ice concentration	
Sea ice thickness	

3.4.6.4 Ice Reporting Procedures

In general, the formatting of ice observations and reports, and the frequency and means of distribution of this information, shall be left to the Operator, appropriate for their needs, and established in the *Ice Management Plan*. The exception to this is ice reports that shall be provided to CIS, CCG, or IIP. Note that information received (from ships) by CCG is relayed to CIS. CIS and IIP share any information they receive. CIS routinely forward observations to CCG for marine navigation. Therefore, outside of Operator *Ice Management Plan* reporting procedures, including any reporting to the Regulator, reports to CIS should suffice.

Iceberg information should be forwarded to CIS in *MANICE* [3] ICE and ICEBERG formats, whenever possible. The essential requirement is timely ice reporting with as much detail as possible. Information received by CIS is coded into ICE and ICEBERG formats (if not already) as a precursor to input to their modelling and operations. Simple worded message formats should be used for any reports to CCG and IIP.

Relevant ice observation, reconnaissance, monitoring, and deflection reports shall be provided to the Regulator in the event that ice enters the Installation's ice alert/response zones or in the event that the Operator undertakes an aerial reconnaissance for their area of interest.

Ice information should also be coded in the MANMAR report and reported according to the marine weather reporting schedule.

The *MANICE* [3] Iceberg Message Code (ICEBERG) accommodates message header, reconnaissance track, individual, cluster, grid and zone observations, and ship location details.

Note that the reporting of no ice occurrence is valuable in itself. During ice season, vessels should report to the Installation Ice Observer any ice observed or explicitly the non-occurrence of ice. As well, the Ice Observer as part of his/her reporting shall also note the absence of ice.

3.4.6.5 Timing

Supply vessels and aircraft, shall report ice information (occurrence and non-occurrence) as part of their regular duties (e.g. at the end of a transit leg) as well as during specific reconnaissance assignments. As a minimum, this information should be conveyed to the ice observer on the installation. The vessel may elect to report observations to CCG or IIP.

For an Ice Observer on the Installation, during ice season, the exact timing and frequency of ice observing will be defined in the *Ice Management Plan*; however, as a minimum, a radar and visual ice watch shall be maintained on a regular basis (several times per hour) especially with known ice in the area.

3.5 Physical Environmental Reports

Physical Environmental reports are described in Section 8 of these *Guidelines*.

3.6 Equipment Requirements

Weather and sea state monitoring equipment should be "fit-for-purpose." The Operator must assess meteorological and oceanographic equipment usage from many perspectives, including the *Regulations*, installation design, safety, cost, availability, standards, and operational perspectives. Each Installation is unique and various equipment types and models may be required. This section describes equipment selection, installation and functional specifications.

3.6.1 Selection and Installation of Monitoring Equipment

Selection and installation of meteorological and sea state monitoring equipment is the responsibility of the Operator. Minimum accuracy specifications for equipment are to be in accordance with WMO and are provided in Appendix B. The Operator will ensure that instruments meet the stated specifications.

Operators in a particular area are encouraged to pool their resources and to consult with the appropriate government agencies (see Appendix G for contact information) with a view to conducting combined measurement programs. In all cases, to ensure appropriate flow of communications, the initial contact should be with the Regulator.

The MSC Port Meteorological Officer (PMO), or other qualified individual, should be consulted for information on the siting of meteorological sensors. The WMO document [14] provides guidance for the siting of meteorological instruments.

3.6.2 Instruments

A variety of instruments and techniques may be used to satisfy the objectives of these *Guidelines*. In addition, environmental conditions and site-specific requirements may vary from region to region, and measurement programs should be tailored for the particular geographic area of operation.

These *Guidelines* do not specify the types of instrumentation that should be used by an Operator, but rather identify minimum standards with which the measurements should comply. Measurement programs should be described in sufficient detail and sufficiently far in advance to permit the Regulator to evaluate the suitability of the proposal to the exploration or development program under consideration. Equipment listed in the *Equipment List* (Appendix C) has been demonstrated to be appropriate for past programs in certain areas.

An Operator intending to work in ice-infested or ice-covered waters, where conventional instrument deployment is difficult or impossible should consider the use of bottom-founded or remote sensing instrumentation. Instrumented moorings, if utilized, are recommended where the moorings are designed for ice-infested waters.

Under the Notice to Shipping, the Operator shall notify CCG of any and all instrument deployments and provide all relevant details as applicable including: nature and description of deployment, latitude, longitude, depths of sub-surface instruments, flasher duration (surface markers shall be outfitted with radar reflectors and a flasher).

All instruments should be calibrated at regular intervals in accordance with the manufacturer's specifications. In there is a suspected problem with the equipment, the equipment shall be calibrated before and after all deployments until such a time that the problem has been rectified.

3.6.3 Monitoring Equipment Specifications

Monitoring equipment specifications are standard for all offshore installations. Appendix D includes an equipment datasheet that each Operator will complete and use as a baseline for equipment purchase. Offshore exploration and producing activities require special equipment consideration to ensure any equipment installation does not impact the safety of the people, environment and installation.

Functional specifications for meteorological and oceanographic sensors are listed in Appendix B.

3.6.4 Integrated Reporting Equipment

Software and hardware "meteorological and oceanographic data integration systems" are used frequently offshore to manage and display data from meteorological and oceanographic sensors. The weather observer may access readings from these systems to prepare weather and sea state reports. For example, software may be used to perform numerical averaging of wind reports, calculate dewpoint, or calculate mean sea level pressure.

It is the responsibility of the Operator to ensure that all software calculations performed by meteorological and oceanographic data integration systems used in aviation weather and marine weather and sea state reports are correct. Validation of derived calculations shall be demonstrated.

3.6.5 Equipment Approval Process

The Operator is not restricted to use equipment described in the *Equipment List*. In the event that equipment to be used offshore is not described in the list, it is the responsibility of the Operator to demonstrate that meteorological and oceanographic equipment meets the functional specifications described in Appendix B.

3.6.6 New Technologies

New technology instrumentation may be capable of obtaining much more information than is possible using present conventional methods. Operators using this instrumentation therefore are encouraged to acquire and archive data at more frequent depth and time intervals. Diagnostic data also should be archived to permit the evaluation of data quality and integrity.

3.7 Quality Assurance

Quality assurance procedures will be applied offshore and onshore, to ensure that observing and reporting errors are minimized (through adherence to procedures), that data flow disruptions are as short in duration as possible, and to ensure that data-user requirements are being met.

3.7.1 Aviation Weather Observing Program

A quality assurance program is required for aviation weather observing programs (see *MANOBS* Version 7). The following guidelines for quality assurance of weather observations are adapted from *WMO 842* [19] and *MANOBS*.

Before observations are made, it is necessary that:

- The observers have adequate training, supplemented by periodic checks on performance;
- The siting and type of instrumentation meet the standards required. Properly applied automation decreases the likelihood of errors;

- The accuracy of measurements or observations is in accordance with the guidance material in ICAO Annex 3 (see Attachment B of that document), and *Guidelines*.

The following checks should be carried out regularly:

- The competence of the observer should be tested;
- To facilitate the comparison of each observation with the previous one, records of observations should be entered on a form, or in a log book, in sequence, before the reports are disseminated;
- Regular checking and monitoring, preventative maintenance or adjustments of instruments should be carried out by suitable trained staff;
- Where instrumental readings must be corrected manually before issue, a methodical procedure should be set up, perhaps necessitating a separate log book detailing the sequence of actions to be undertaken;
- When the report is completed and ready for transmission, each item should be checked individually.

In addition, software should be used to check for intra-parameter and temporal consistency of observations.

3.7.2 Oceanographic Observing Program

A quality assurance program is required for oceanographic observing programs. Before observations are made, it is necessary that:

- The Marine Weather Observer has adequate training, supplemented by periodic checks on performance;
- The siting and type of instrumentation meet the standards required. Properly applied automation decreases the likelihood of errors;
- The accuracy of measurements or observations is in accordance with the guidance material in the *Guidelines*.

The following checks should be carried out regularly:

- The competence of the Marine Weather Observer should be tested;
- To facilitate the comparison of each observation with the previous one, records of observations should be entered on a form, or in a log book, in sequence, before the reports are disseminated;
- Regular checking and monitoring, preventative maintenance or adjustments of instruments should be carried out by suitable trained staff;
- Where instrumental readings must be corrected manually before issue, a methodical procedure should be set up, perhaps necessitating a separate log book detailing the sequence of actions to be undertaken;
- When the report is completed and ready for transmission, each item should be checked individually.

4.0 WEATHER FORECASTING

Two types of weather forecast services are normally required: site-specific marine forecast services for normal and emergency conditions related to drilling or production operations; and aviation weather forecast services for support flights.

4.1 Site-Specific Marine Weather and Sea State Forecasting

The Operator shall arrange for site-specific weather and sea state forecasts in support of their operations. These should meet the needs of both normal and emergency operations and should be provided by a qualified Weather Forecasting Contractor.

The forecast shall be prepared by a qualified Meteorologist. If a major departure from the MSC regional forecast appears warranted, the forecaster preparing the site-specific forecast should consult with the appropriate MSC Weather Centre.

The Weather Forecasting Contractor should be familiar with the requirements for forecast services contained in the Operator's Contingency and Response Plans. It is the responsibility of the Operator to provide this information to the Weather Forecasting Contractor.

Essential elements of the site-specific forecast service include:

- Forecast issuance at least every 6 hours, or more frequently as required.
- A qualified meteorologist who has access to all available and appropriate meteorological and other data shall maintain a continuous weather watch.
- Data sources shall be sufficiently secure and redundant to enable guaranteed data access at all times.
- A forecast amendment service with defined forecast amendment criteria (threshold values).
- Forecast for each synoptic (i.e. 00, 06, 12, 18 UTC) hour in the forecast period of wind speed and direction, sea state (wave and swell height, period and direction), precipitation, visibility, sky conditions, air temperature, freezing spray and icing conditions (when appropriate); and a synopsis of present weather patterns.
- Forecasts should extend over, at least, a 48-hour period.
- An outlook covering the period from the last valid time of the forecast out to 120 hours should be included and should be more qualitative in content than the forecast.
- In the case of an emergency, special forecasts tailored to the emergency should be prepared and updated as required.
- An effective data communications system is required to ensure the timely transmission and receipt of environmental data and forecasts.

4.2 Aviation Forecasting

TC requires that graphical area forecasts (GFAs) be available to support aviation services to offshore installations. These forecasts are provided by MSC. Aviation observations from offshore installations, prepared according to the standards listed in Section 2.0, are required

to support the preparation of GFAs. Aviation observations shall be provided to MSC in real-time.

The Operator may arrange for the provision of terminal aviation forecasts (TAFs) from either a government or private forecast provider. These TAFs will be prepared in accordance with standards and procedures defined in *MANAIR*. The provider of TAFs to an Installation must be approved to issue these aviation forecasts by TC.

5.0 FORECAST VERIFICATION

Forecast verification is performed to enable offshore Operators and the Regulator to assess the skill and reliability of the forecast program. Confidence in the forecast will enable the Operator to use the forecast as guidance for making operational decisions.

In order to provide reliable forecasts and verification statistics it is incumbent on the Operator to provide the forecasting contractor with access to accurate and timely observations.

Verification statistics are a measure of the agreement between forecasts and observations. Hence, they are an indication of the joint effectiveness of the observing and forecasting programs.

The principle objectives of forecast verification are:

- Evaluation of the accuracy of the forecasts;
- Evaluation of the accuracy and representativeness of observations;
- Investigation of trends in the forecasts, and thereby improvement of their quality; and,
- Improved knowledge of the impact of weather and weather information on offshore operations, as a means of risk assessment.

5.1 Meteorological and Oceanographic Forecasts

It is recommended that a forecast verification analysis, as presented in Appendix E, be an integral component of the site-specific marine and aviation (if present) forecast programs, and should be described in the Operator's *Program Description*. It is the responsibility of the Operator to establish, in combination with the Operator's forecasting agencies, a forecast verification system that is effective in meeting the above objectives.

Verification results should be provided to the Operator on a monthly basis. To obtain meaningful results, a threshold analysis (see Appendix E) shall be calculated on the basis of a reasonable time frame that will provide a sufficient number of threshold-exceeded events. For longer drilling or production programs the statistics should be calculated on a seasonal basis, while for shorter (1 to 4 months) drilling programs the duration of the drilling or production program may be a more reasonable time frame for the calculations.

5.2 Ice Management

The Operator shall obtain forecasts of ice movements on a daily basis. The CIS ice charts are one such source of daily ice forecast information. As part of their *Ice Management Plan*, the Operator shall have available sea ice and iceberg trajectory forecasting capabilities to address specific tactical requirements.

The Operator shall ensure that for any instances in which these tools are used, that as much detailed iceberg position and drift track observation and modeling information is recorded to assist in forecast verification at a later date. For all ice seasons in which tactical ice

forecasting was conducted, the Operator shall ensure that a forecast verification report is compiled following the end of the Ice Season.

A forecast verification system should be implemented to provide verification data for any ice and iceberg forecast system. All forecast verification systems to be used by the Operator should be described in the *Program Description*. The forecast verification system should be tailored to the Operator's operations.

6.0 ARCHIVING

The intent of these *Guidelines* is that all physical environmental data measured offshore will be archived by government agencies for future use.

6.1 Archive Content

It is the responsibility of the Operator to ensure that the following reports are delivered in real-time and in a format acceptable to the appropriate government agencies:

- Metadata reports;
- Marine (MANMAR and WAVEOB) observations;
- Aviation (METAR and SPECI) observations, provided that MSC uses these data operationally; and,
- Ice (ICE and ICEBERG) observations.

Government agencies have full license to archive and use these Operator-provided real-time reports.

The Operator is responsible for delivering all original meteorological (marine and aviation as appropriate) paper-copy reporting forms to MSC after well completion, or annually for a production Installation. MSC uses the paper-copy reporting forms for quality assurance of the observations.

Meteorological, oceanographic and ice measurements obtained from offshore-deployed sensors are to be delivered to the appropriate government agencies in addition to the real time data. The Operator will contribute a minimum, and defined data set of measurements. The Operator will also contribute any other available measurements if available.

The Operator shall deliver, as a minimum, the following measurements:

- Ocean current measurements at "near-surface", "mid-depth" and "near-bottom";
- Significant and maximum wave height, wave peak period and wave spectra measurements;
- Wind speed and direction measurements; and,
- Air temperature and humidity (wet-bulb, dewpoint or relative humidity) measurements.

Table 6-1 summarizes the minimum set of reports and measurements to be delivered by the Operator

Table 6-1 – Minimum Meteorological and Oceanographic Sensor Measurements

Parameter	Recording Interval	Notes
Metadata reports	As need	**Format under development**
Marine (MANMAR) reports	3-hourly	**MANMAR** report is transmitted in near real time.
Aviation (BUFR) reports	as recorded	**BUFR** report is transmitted in near real time.
Ice (ICE and ICEBERG) reports	as recorded	**ICE** and **ICEBERG** reports are transmitted in near real time.
10 minute averaged wind speed and direction	10 minutes	Instrument specific format.
1 minute averaged wind speed and direction	Hourly	Instrument specific format.
Significant wave height (Hs)	20 minute	Instrument specific format.
Maximum wave height (Hmax)	20 minute	Instrument specific format.
Average Period	20 minute	Instrument specific format.
Wave spectrum	20 minute	Instrument specific format.
1-minute-averaged Air Temperature	Hourly	Instrument specific format.
1-minute-averaged dew-point or wet-bulb or relative humidity	Hourly	Instrument specific format.
Ocean currents (eastward and northward components)	See note[3]	Instrument specific format. Minimum near-surface, mid-depth and near-bottom required.

6.2 Data Access

It is the responsibility of the Operator to ensure that physical environmental data identified in this Guideline are collected and delivered to the appropriate government agency.
Electronic copies of all meteorological, oceanographic and ice forecasts shall be delivered to the Operator as part of the Physical Environmental Report (Section 8).

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[3] Ocean currents will be measured with a view to resolution of oceanographic processes. These will generally include tide and non-tide components and may also include vertical structure.

7.0 TRAINING

7.1 Meteorologist

A qualified meteorologist may be any graduate of a specified program in meteorological studies at a recognized university and/or anyone having completed a course of studies prescribed by a major national weather service such as the MSC in Canada or the United States' National Weather Service.

Meteorologists shall have the following:

- Specialized training in marine meteorology, sea state forecasting, and (as appropriate) forecasting in the marginal ice zone. Understanding of local weather features and patterns is highly desirable.

- Periodic and ongoing training in data and guidance assessment, and forecast techniques, periodic and ongoing training in the Operator's Contingency and Response Plans.

7.2 Meteorology

The observers taking meteorological observations on the Installation must have successfully completed approved training by a qualified weather observer instructor dealing with the procedures for observing, recording, and reporting weather, sea state and ice parameters. Offshore observers must be qualified to take marine and aviation observations. The Operator is responsible for ensuring that observers meet Industry and government-developed standards for offshore weather observing.

The Operator shall:

- Maintain detailed training records for each trained person;
- Establish and document standards and methods for training whereby personnel demonstrate the ability to take meteorological observations and for persons taking aviation weather observations, provide meteorological reports in accordance with the requirements of the *Canadian Aviation Regulations*;
- Determine and set limitations on the tasks to be performed by personnel based on their training and demonstrated competence.

The Operator shall establish processes and procedures for the certification of personnel and provide personnel with evidence of certification which is available on-site during their regular work routines.

Personnel, who have been qualified by the Operator to take aviation and/or marine observations, are qualified to observe and record only. Interpretation of meteorological forecasts and/or weather charts will be performed by a qualified meteorologist or experienced weather observer.

All efforts should be made to ensure that a qualified observer is present on each Installation at all times. Only a qualified Meteorologist can issue or modify offshore meteorological forecasts. Weather forecast interpretation may be provided by the meteorologist or an experienced weather observer.

7.3 Oceanography

The Marine Weather Observer and Aviation Weather Observer shall be trained in the use of oceanographic equipment to appropriately prepare aviation and marine reports. The Operator will prepare observing and reporting procedures that are appropriate for the instrumentation used on an Installation. Observers will be tested in the use of oceanographic instruments required for aviation and marine observations.

7.4 Ice Management

Personnel, who have been qualified by the Operator to take ice observations should be familiar with, and have an understanding and working knowledge of, all aspects and elements of the Operator's *Ice Management Plan*, and of the relevant terminology, observations, ice chart, and ice and iceberg reporting messages chapters of *MANICE* and *MANMAR*.

8.0 REPORTS

A summary of all hard copy reports is provided in this section.

8.1 Environmental Monitoring Program Description

The contents of this report are outlined in Section 1.2 of these *Guidelines*. Operators are advised to consult the Regulator regarding the number of paper and electronic copies required.

8.2 Ice Management Plan

A requirement of the *Production and Conservation Regulations*, the Operator shall prepare, as appropriate, an *Ice Management Plan* which shall be submitted for approval to the Regulator as part of the Authority to Drill a Well (ADW). Refer to Appendix F. Operators are advised to consult the Regulator regarding the number of paper and electronic copies required.

8.3 Physical Environmental Reports

Physical Environmental Reports are required to be submitted as part of the Final Well Report. In accordance with subsection 201(1) of the drilling regulations, the report is to be submitted within 90 days of the well termination date in the case of an exploratory well and within 45 days in the case of a development well. For production programs, reports are to be supplied to the Regulator annually, on a calendar year basis, by March 1st of the succeeding year. Operators are advised to consult the Regulator regarding the number of paper and electronic copies required.

The Physical Environmental Report should contain:

1. Meteorological Data Report
2. Forecast Verification Report
3. Oceanographic Data Report
4. Ice Data Report (if applicable)

8.3.1 Meteorological Data Report

The report should include:

a) A description of any changes to the meteorological data collection and weather observing programs which occurred after the submission of the Environmental Monitoring Program Description report, as outlined in Section 1.2 of these *Guidelines*.
b) Copies of all metadata reports which were submitted during the program.
c) Copies all marine and aviation data reports on acceptable data storage media.
d) Recommendations for change in any future measurement program.

e) There is NO requirement for in depth analysis of meteorological data (extremes, wind roses, etc.)
f) Marine reports (MANMAR) from the program should be transmitted to MSC's National Climate Archive Service at National.Climate.Archive.Services@ec.gc.ca
g) Archived meteorological sensor data as described in Section 6, on acceptable storage media.

8.3.2 Forecast Verification Report

The report should include:

a) Weather forecast verification statistics as described in Appendix E of these *Guidelines* and in accordance with Operator's instructions.
b) Time series reports may be submitted on appropriate storage media and need not be reproduced in hard copy.
c) Electronic copies of all weather forecasts.

8.3.3 Oceanographic Data Report

The report should include:

a) A description of any changes to the oceanographic data collection that occurred after the submission of the Environmental Monitoring Program Description report, as outlined in Section 1.2 of these *Guidelines*.
b) Recommendations for change in any future measurement program.
c) Archived oceanographic sensor data (see Section 6) should be submitted to the Regulator on acceptable data storage media.
d) All oceanographic data in a format suitable for archiving at MEDS as described in Appendix A.

8.3.4 Ice Data Report

The report should include:

a) A description of any changes to the ice data collection which occurred after the submission of the Environmental Monitoring Program Description report, as outlined in Section 1.2 of these *Guidelines*.
b) Ice forecast verification statistics as described in Appendix E of these *Guidelines*.
c) Archived ice data on acceptable storage media.
d) Electronic copies of all ice forecasts.

9.0 REFERENCES

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[16] World Meteorological Organization, 1988: *Manual on Codes, Volume 1, International Codes, Part B-Binary Codes*, 1988 Edition. WMO, Geneva.

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Appendix A

Recommended Data Format

January 2004

Data Formats

The essential requirements for data formats are:

- All key information is included,
- An appropriate format is selected, and
- Complete documentation is specified.

The following categories of formats are recommended:

- WMO character-based and binary formats
- Generic formats
- Instrument-specific formats (provided other formats are not suitable)

WMO formats are used for marine, aviation and ice observations that are distributed to government and Industry agencies in real-time. Generic formats are used for the sharing of Industry data, and for Industry-based archival. Instrument-specific formats are used when the nature of the data to be archived is not practically served by one of the other formats. Public-domain software exists to facilitate work with these formats.

Summary of Report and Data Product Formats

Table 1-1 summarizes formats for each of the possible reports or data products that may be used in a Monitoring Program. Wherever possible, standard data formats should be used. Data element reporting (i.e. use of the BUFR format) is encouraged. A description of the different format types is provided in the following sections.

Table 1-1 - Formats for Reports and Data Products

Report or Data Product	Recommended Format	Notes
Aviation Weather Report	BUFR	BUFR converted to METAR by MSC, then distributed.
Marine Weather Report	MANMAR	BUFR may also be used if subsequent conversion to MANMAR is made.
Ice Report	ICE	
Iceberg Report	ICEBERG	
Wave Spectral Data Report	ASCII	
Ocean Current Data Reports	GF-3[1]	
Sensor data used for Installation-specific operations	Instrument-specific	
Sensor data to be shared between Installations	At Operator's discretion	

[1] GF-3 format is required for submission of current meter data to MEDS from conventional moored instruments. Acoustic Doppler Current Profiler (ADCP) data may be submitted in the vendor's specific format providing all of the essential support documentation in included.

Report or Data Product	Recommended Format	Notes
Field (i.e. gridded spatial) Data	GRIB	Field data is typically provided by contractors or government agencies, not by the Operator.
Miscellaneous Data	Instrument-specific	

WMO Formats

The Canadian, MANAIR [4], MANOBS [1] and MANICE [3] manuals use WMO-developed and maintained character-based formats for the coding of marine, aviation and ice reports. These reports are distributed on Canadian and international telecommunications circuits.

The **MANMAR** format is used to code marine weather and sea state observations. The **BUFR** binary format is used to code aviation weather observations. The **ICE** format is used to code ice data. These data shall be archived in these WMO formats.

There is also a WMO character-based format for coding wave spectra data from sea sensor systems. The WMO FM 65-IX **WAVEOB** format can be used to distribute wave spectral data in real-time. This information is useful for determining the response of floating vessels to wave conditions.

Any spatially gridded (i.e. field) data, used to represent, for example, analyzed and forecast:

- Ice concentration,
- Winds,
- Temperatures,
- Wave heights and swells;
- Ocean currents

should be archived in the GRIdded Binary (**GRIB**) format (see below).

Generic Formats

Generic data formats are required to facilitate sharing of information between installations and operators.

Two generic (i.e. data element and sensor independent) data formats are recommended for offshore physical environment monitoring applications:

- The **BUFR** format (this is a WMO binary format)
- The **GRIB** format (this is a WMO binary format)

The **BUFR** (Binary Universal Form for the Representation of meteorological data) is an international code (WMO code FM 94) that can be used to represent any meteorological, oceanographic and ice data type. The **BUFR** code is defined in [16] and described in [9] and [18]. **BUFR** is recommended for data distribution, archival and installation data-sharing applications. **BUFR** is well suited for representing observational data, including remotely-sensed imagery and radar data.

The **GRIB** (Gridded Binary) format is an international code (WMO code form FM 92) that can be used to represent and meteorological, oceanographic and ice data type. While **BUFR** is used to represent point measurements, **GRIB** is suited for field data, such as analysis and forecast field data. The **GRIB** code is defined in [16] and described in [10] and [18]. **GRIB** is recommended for data distribution, archival and Installation data-sharing applications involving field data.

It should be noted that marine (**MANMAR**), aviation (**METAR**), and ice (**ICE**) observations could be converted into the **BUFR** format (and vice versa).

Instrument-Specific Formats

It may be appropriate in some situations to archive data in instrument-specific formats. Wave spectra and ADCP current profile data are possible examples of this. In the situation where instrument-specific data are archived, the Operator shall confirm with the Regulator or appropriate government agency (such as MEDS), that these formats are consistent with the intended use of the data. In general, the use of WMO and generic formats is preferred to instrument-specific formats.

Appendix B

Monitoring Equipment Specifications

January 2004

Accuracy Specifications			Collection Specifications[4]	
Sensor	Accuracy	Sensor Requirements	Averaging Intervals	Recording Intervals
Wind Speed	± 1 kt up to 20 kts ± 5% for speed > 20 kts	• resistance to icing[5] • capability to digitally estimate 10-minute and 2-minute averages (preferable vector averages) • capability to digitally estimate 1-minute and 1-hour averages (preferably vector averages) **suggested** • digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)	1 minute (suggested) 2 minute 10 minute 1 hour (suggested)	10 minutes (10 minute average, hourly otherwise)
Wind Direction	± 5 degrees	As per wind speed	As per wind speed	As per wind speed
Pressure	± 0.1hPa (barometer reading) ± 0.2 hPa (sea level pressure[6]) ± 0.01hPa (QNH altimeter setting)	• capability to display 3-hour time trace required for tendency characteristic • digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment installed[7])	Instantaneous	1 minute
Air Temperature	± 0.5 degrees Celsius	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)	1 minute	1 minute
Humidity (wet bulb)	± 0.5 degrees Celsius	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)	1 minute	1 minute
Cloud Height	± 10 m up to 100 m ± 10% from 100 m to 300 m ± 20% for above 300 m	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)	1 minute	1 minute

[4] Sensor model/serial number, sensor height, siting description, record specification, trip report (if req'd), local chart datum (if req'd), equipment data sheet
[5] Resistance to icing means "continued operation during light to moderate icing conditions."
[6] Derived pressure readings depend on parameters additional to the barometer reading, including temperature readings and height of the barometer above mean sea level.
[7] Barometers may not be exposed to the full range of temperatures that an installation may experience if installed in a heated area.

Accuracy Specifications			Collection Specifications[4]	
Sensor	Accuracy	Sensor Requirements	Averaging Intervals	Recording Intervals
Cloud Amount	1 okta (1/8th of the sky)	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)	1 minute	1 minute
Precipitation Amount	0.1 mm up to 10 mm ± 2% for above 10 mm	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used) • heating unit may be required for cold-season applications	1 minute	1 minute
Visibility	± 50 m up to 500 m ± 10% from 500 m to 1500 m ± 20% for beyond 1500 m	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)	1 minute	1 minute
Wave Height	± 3% for periods 2 to 20 s ± 6% for periods 21 to 30 s	• operation over range 0 to 30 m • recording interval between 17.5 and 35 minutes • continuous recording interval height criteria reached • digital output (real time or archival) capability	Combined Significant Wave Height **20 minutes** Maximum Wave Value **20 minutes** Wave Spectral Period **20 minutes** Wave Spectra **20 minutes**	Combined Significant Wave Height **20 minutes** Maximum Wave Value **20 minutes** Wave Spectral Period **20 minutes** Wave Spectra **20 minutes**
Wave Direction (s)	± 5 degrees	• recording interval between 17.5 and 35 minutes • continuous recording interval height criteria reached • digital output (real time or archival) capability		
Sea Surface Temperature	± 0.5 degrees Celsius	• operation over range of –2°C to 25°C	1 minute	1 minute[1]
Water Level	± 0.01 metre	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)	10 minutes	1 hour

[1] Recording and averaging intervals for obtaining sea surface temperatures will require further discussion. This is attributed to past history, the overall design of an offshore installation and the effectiveness of measuring temperature from an installation or standby vessel.

Accuracy Specifications			Collection Specifications[4]	
Sensor	Accuracy	Sensor Requirements	Averaging Intervals	Recording Intervals
Water Temperature	± 0.5 degrees Celsius	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)		
Salinity	± 1 parts per thousand	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)		
Depth	± 0.2 metre	• digital output (real time or archival) capability **suggested** • operation over full temperature range (for region in which equipment used)		
CTD				
Ocean Currents: horizontal current speed and direction	± 0.02 m/s for range 0–3 m/s ± 5° for range 0-360°	• record at depths ≥ depths: surface, mid-depth and near bottom • record for at least 30 minutes every hour • apply averaging intervals of at ≥ 5 minutes		No longer than ½ hour

OCEANOGRAPHIC

Mooring Considerations

Moorings or deployments should be maintained in one location for as long as possible and need not be moved with every relocation of an Installation in a particular area. Consideration should be given to mooring or deployment longevity rather than relocation, whenever possible. Both the location and design of the moorings or deployment must be approved by the Regulator prior to deployment.

The wave measuring instrument should be located so that the wave field being measured is not disturbed by the Installation and located sufficiently close to the Installation so that reliable communications between the wave instrument and the receiver on the Installation are maintained. The instrument should also be located so that the wave field being measured is not substantially altered from that at the site of the Installation because of sheltering, bottom effects, etc., or in general have a different exposure to prevailing conditions.

ICE MANAGEMENT

Instruments for ice detection and monitoring equipment primarily include radar, which are generally operated from a drilling unit, ship, or aircraft. Instruments should be selected to optimize performance in a number of areas, including: range, target size detection and detection of small ice masses, detection in poor weather and sea conditions, and target tracking. *In situ* measurements of above-surface iceberg size are generally obtained using camera or sextant. Sonar and other underwater equipment, ROV or AUV, are generally used for draft measurement.

The Operator is encouraged to discuss existing or potential instrument and detection and measurement technologies with other operators and ice service groups to ensure that the most appropriate tools are used.

Appendix C

Equipment List

January 2004

GENERAL

This Equipment List describes instruments that may be used in an Offshore Physical Monitoring Program. This list is preliminary and provided for information only.

Note i: g.f. = "grandfathered" equipment. Although the equipment may be used as part of an existing system, it may not be added as part of a new system.

Note ii: Temperature and pressure instruments require calibration certificates and correction cards issued by an acceptable lab.

METEOROLOGICAL INSTRUMENTS

Cloud Height

[1] MSC Ceiling Projector 16 with alidade (500 ft or 1000 ft baseline)
[2] Vaisala CT25K with acceptable display (pending approval by CMB)
[3] Vaisala CT12K with acceptable display
[4] MSC Ceiling Balloons with balloon filling equipment (using helium or hydrogen)

Visibility

[1] Visibility Chart Form 0063-9046 that has been completed and approved by qualified meteorological inspector.
[2] Suitable map that has been approved by qualified meteorological inspector

Occurrence of Weather Phenomena

[1] Ice Accretion Indicators
[2] MSC tipping bucket rain gauge with recorder

Atmospheric Pressure

[1] Ruska 6220 (with desiccant cartridge if used for inspection)
[2] Druck DPI140
[3] Paroscientific Digiquartz 760-16B (station and inspection)
[4] Paroscientific Digiquartz 6016B
[5] Solartron DPM 7885 (with desiccant cartridge)
[6] Vaisala PTB220A (3 transducers, Class A calibration)

Temperature/Humidity

Note.: Temperature and Dew Point values obtained from thermometers shall be located in a ventilated Stevenson Screen type shelter. Specifications for thermometers require that the scale error at any point in the range does not exceed 0.2 C. Additionally, readings from thermometers paired for a psychrometer should read within 0.2 C of each other under like conditions.

Temperature

[1] RTD-87 MSC Remote-Temperature Dew-Point System (1987) with display
[2] Vaisala HMP 45A with 2212 HM solar radiation shield, Vaisala
[3] Vaisala HMP 45D with 2212 HM solar radiation shield, Vaisala
[4] Yellow Springs Instruments Model 44212 Thermistor (must have conditioning electronics)
[5] MSC Ordinary Mercury Thermometer with correction card
[6] MSC Sling Psychrometer
[7] MSC Minimum Thermometer

Temperature (Estimated T-12 as per MANOBS)

[1] Thermograph or Lambrecht Thermohygrograph

Humidity

[1] RTD-87 MSC Remote Temperature Dew-Point System (1987) with Display
[2] Vaisala HMP 45A with 2212 HM solar radiation shield, Vaisala
[3] Vaisala HMP 45D with 2212 HM solar radiation shield, Vaisala
[4] MSC Ordinary or Ordinary for Sling Mercury Thermometer with correction card
[5] MSC Type A-E Dewcel
[6] MSC Sling Psychrometer

Wind Direction and Speed

Measured Wind Direction and Speed

[1] MSC Type U2A Anemometer , 110 or 32 Volt system with approved chart recorder or indicator.
[2] MSC Type 78D Anemometer with approved recorder or indicator
[3] Vaisala WAA251 Heated Anemometer, Vaisala
[4] Vaisala WAV151 Heated Wind Vane, Vaisala

Estimated Wind Direction and Speed

[1] Beaufort Wind Scale
[2] TurboMeter hand held, Davis Instruments
[3] g.f. Anemometer, Lambrecht, hand held, 0 - 60 knots

Precipitation Amount

[1] MSC Type B rain gauge (large capacity, complete)

Data Input Software

Official **METAR** reports, which are transmitted to MSC, shall not be created directly at any site. Rather, observers shall enter data elements into approved data entry screens, or AWOS data elements shall be automatically ingested into the data entry screens using approved software. Observations shall be transmitted in an approved elemental form to the Environment Canada's National Communications Processor (NCP) where **METAR** reports are created and redistributed. METAR reports which are generated for internal use by the Operator and its Contractors may be generated at the site.

[1] Windows Interactive Data Entry (**METAR**) v x.x
[2] Multi-purpose Information Display System (MIDS) v x.x
[3] Flight Information System (FIMS) v x.x

OCEANOGRAPHIC INSTRUMENTS

Sea State

[1] Datawell Standard Waverider, Datawell
[2] Datawell Directional Waverider, Datawell
[3] MIROS Wave Radar, MkII, MIROS A/S
[4] Triaxys Directional Wave Buoy, Axys Environmental Systems
[5] Oceanor Seawatch Buoy, Oceanor ASA
[6] Oceanor Wavescan Buoy, Oceanor ASA

Sea Surface Temperature

[1] MSC SST Bucket and SST thermometer

Ocean Currents and/or Conductivity, Temperature, Depth (CTD)

[1] MIROS Wave Radar Mk2, MIROS A/S (surface currents)
[2] RDI Workhorse Sentinel Acoustic Doppler Current Profiler (1200/300 kHz, RD Instruments
[3] Aanderaa Doppler Current Meter, DCM 12, Aanderaa
[4] Aanderaa Recording Current Meter, RCM 8/9, Aanderaa
[5] InterOcean S4/S4A/S4P/S4D Current Meter, InterOcean
[6] Aanderaa Conductivity / Temperature Profile Recorder CTR 7, Aanderaa
[7] Sea-Bird 911/911plus CTD, Sea-bird Electronics
[8] Sea-Bird SBE 25 Sealogger CTD, Sea-bird Electronics

Water Level

[1] Aanderaa Water Level Recorder, WLR 7/8, Aanderaa

ICE MONITORING INSTRUMENTS

Iceberg Draft

Imagenex 855-000-110 Color Imaging (Sector Scan) Sonar, Imagenex

Appendix D

Monitoring Equipment Data Sheet

January 2004

Overview

All equipment used offshore shall be documented using equipment data sheets. These data sheets are used for documentation of offshore physical environmental measurements. The Industry contact should be contacted to obtain digital copies of the form or if explanation is required.

Instructions

All entries of the Data Sheet should be filled in, if possible. The first column of the form, entitled "requirements", identifies the information that is required. The second column, entitled "description" is to be filled in by the Operator or appropriate contractor. The third column can be used to identify "notes", should there be insufficient space on the form for all information. All Data Sheet data should be provided in digital form (WordPerfect™, Microsoft Word™, or ASCII formats are acceptable), for inclusion in the Physical Environmental Report.

Data Sheet Form

MEASURED PARAMETERS & ASSOCIATED MONITORING EQUIPMENT			
Item	Requirement	Description	See Note
	GENERAL		
1	Manufacturer		
2	Model Number		
3	Supplier		
4	Type of Equipment		
5	Construction		
6	Mounting & Adjustment		
7	Accessories		
	PERFORMANCE STANDARDS		
8	Accuracy		
9	Operating Temperature		
10	Measurement Range		
11	Response Time		
12	Mean Time Between Failures		
13	Response to Obstructions		
	ELECTRICAL REQUIREMENTS		
14	Hazardous Area Classification		
15	Power Supply		
16	Platform Electrical Frequency		
17	Output Signals		
18	Connection Details		
	ENVIRONMENTAL		
19	Ingress Protection (e.g. IP, NEMA)		
20	Typical Environmental Conditions		
	MAINTENANCE		
21	Test Methods		
22	Manuals		
	QUANTITY & TAGGING		
23	Quantity		
24	Tag Numbers		
	DOCUMENTATION		
25	Certification		

Appendix E

Forecast Verification

January 2004

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E.1 OVERVIEW

Forecast verification is performed to enable offshore operators to assess the skill and reliability of the forecast program. Confidence in the forecast will enable the operator to use the forecast as guidance for making operational decisions.

In order to provide reliable forecasts and verification statistics it is incumbent on the operator to provide the forecasting contractor with access to accurate and timely observations.

Verification statistics are a measure of the agreement between forecasts and observations. Hence, they are an indication of the joint effectiveness of the observing and forecasting programs.

The principle objectives of forecast verification are:

- evaluation of the accuracy of the forecasts;
- evaluation of the accuracy and representativeness of observations;
- investigation of trends in the forecasts, and thereby improvement of their quality; and,
- improved knowledge of the impact of weather and weather information on offshore operations, as a means of risk assessment.

It is recommended that a forecast verification analysis, as presented in this Appendix, be an integral component of the forecast program.

E.2 RECOMMENDED PARAMETERS FOR VERIFICATION

The key parameters that impact on an offshore marine operation are wind speed, wind direction and wave height. It is recommended that these parameters, as a minimum, be verified for all meteorological forecast programs. Other parameters, such as air temperature and visibility may be important to an operation.

Predicted iceberg positions should be verified for an iceberg trajectory forecast program.

Predicted ocean currents should be verified for an oceanographic forecast program.

The Operator is responsible for determining which forecast parameters are verified.

E.3 OBSERVATIONS

An observation value used for verification purposes should correspond as closely as possible with the corresponding forecast parameter definition (see next section). This correspondence may be difficult to achieve because of observation limitations due to imperfect siting of instruments, and other factors. Obstructions from the Installation superstructure and thermal effects, for example, can prevent instruments from recording ambient conditions.

For example, it may be necessary to:

- Remove any known bias from the observations. In the case of wind observations there may be both speed- and direction-dependent observational errors that should be removed before observations are used in a verification analysis.
- Apply any spatial and/or temporal averaging to match observation definitions with those of the corresponding forecast parameters.
- Apply any necessary adjustments to make observations and forecast reference the same height above sea level.
- Apply any necessary physical derivations. An example would be to verify humidity forecasts using dry-bulb and wet-bulb temperature measurements.

Further, observations used in the verification system must correspond in definition to the forecast parameters to be verified (see the next section). For example, the following formula may be used to process observations used in a verification system:

$$O_t = \frac{1}{5}(o_{t-3} + 3o_t + o_{t+3}) \qquad \textbf{Equation 1}$$

where the o_t are observed winds for the valid time t, 3 hours prior to the valid time, and 3 hours after the valid time. Marine wind observations (i.e. MANMAR [4] winds) may be processed using Equation 1, for example. Different expressions would be used if aviation observations or "sensor values" were used in the verification system.

E.4 FORECASTS

Precise definitions of the forecast parameters being verified are required. That is, the following must be defined for each forecast parameter:

- the applicable horizontal and vertical spatial area;
- the vertical reference height;
- the temporal representativeness; and,
- the (sampling) averaging interval.

For example, 10-minute averaged forecast winds valid at an anemometer height of 60 metres, may be verified. If the forecast winds are considered representative of winds near the Installation, then they may be designed to represent a circular area with a radius of 5 nautical miles. Further, the forecast winds may represent a 6-hour time period centred on the forecast valid time, according to the averaging formula:

$$F_t = \frac{1}{5}(f_{t-3} + 3f_t + f_{t+3}) \qquad \textbf{Equation 2}$$

where the f_t are forecast 10-minute-average winds for the valid times t, 3 hours prior to, and 3 hours after the valid time. The definitions of forecast parameters should be well known to all users of the forecast.

E.5 TIME SERIES PLOTS

A set of monthly time-series plots of forecast and observed parameters is a recommended component of the verification. As discussed in Section E.3 any calculations required to make observations and forecasts correspond should be performed prior to plotting. Plots for the 12, 24, 36 and 48 hour forecast lead times may be plotted. For the purposes of verification, lead times shall be based on the date/time of the latest completed synoptic analysis upon which the forecast is based. For example, a forecast issued at 240700 UTC, based upon a 240000 UTC synoptic analysis, shall have a 36 hour validation time at 251200 UTC. Consistent vertical and time axes should be used. It is useful to plot any operational threshold values on the time-series plots.

E.6 VERIFICATION STATISTICS

A set of verification statistics is recommended. The following statistics are described in the following sub-sections:

- Error
- Bias
- Mean Absolute Error
- Root Mean Square Error
- Skill Score

E.6.1 Error

The difference between the forecast and the observation, at a given time t, is given by:

$$E_t = F_t - O_t \qquad \textbf{Equation 3}$$

The forecast error is given by:

$$E_t^f = F_t - T_t \qquad \textbf{Equation 4}$$

and the observing error is:

$$E_t^o = O_t - T_t \qquad \textbf{Equation 5}$$

where T_t is the "true value," that is, the value that would be measured by an unbiased (i.e. perfect) instrument. The above definitions for error show that:

$$E_t = E_t^f + E_t^o$$ **Equation 6**

That is, both the forecast and the observation have error components. Observation errors should be removed, if possible, before observations are used in a verification system. Otherwise the verification statistics unduly reflect errors in both the observation and forecast programs. Observation error assessment is an observing program quality assurance procedure.

E.6.2 Bias

The bias is given by:

$$BIAS = \frac{1}{N}\sum_{t=1}^{N}(F_t - O_t)$$ **Equation 7**

The bias indicates the average of the deviation of the forecast from the observations. The bias can be either negative or positive. Bias is a measure of the "direction" (i.e. positive or negative) but not the magnitude of the errors, and should be near zero.

E.6.3 Mean Absolute Error

The mean absolute error (MAE) is given by:

$$MAE = \frac{1}{N}\sum_{t=1}^{N}|F_t - O_t|$$ **Equation 8**

This statistic gives a measure of the average magnitude of errors, but does not indicate the direction of the errors. The MAE is always positive and less than or equal to the root mean square error.

E.6.4 Root Mean Square Error

The root mean square error (RMSE) is given by:

$$RMSE = \sqrt{\frac{\sum_{t=1}^{N}(F_t - O_t)^2}{N}}$$ **Equation 9**

This statistic also gives a measure of the average magnitude of errors, and does not indicate the direction of errors. Compared to the MAE, the RMSE gives greater weight to large errors than to small errors in the average. That is, if RMSE is much greater than MAE then a high frequency of large errors is indicated. It is therefore an appropriate statistic to use when large errors are particularly undesirable. This statistic encourages "hedging," as a

forecaster can reduce the RMSE by forecasting in the mid-range of possible outcomes (i.e. not predicting extreme values).

E.6.5 Skill Score

The skill score is given by:

$$SS = \frac{R - E}{T - E}$$ **Equation 10**

where:

R is the number of correct forecasts
T is the total number of forecasts
E is the number expected to be correct based on climatological values for the given area derived from MAST data for the local area.

Note that:

SS = 1 when all forecasts are correct;
= 0 when number correct is equal to expected; and,
= a negative value when the forecast has negative skill with reference to knowledge of the local climate.

The skill score thus defined, expresses as a decimal fraction the percentage of forecasts which are correct after those forecasts have been eliminated from consideration which would have been correct on the basis of a knowledge of local climate.

Characteristics of the Skill Score are:

- The range of the skill score is from +1 to -00, where -00 is mathematically possible with a perfect standard forecast (E=T and E>R) and is independent of how accurate the actual forecast has been (only limitation E>R).
- The better the MAST standard, the smaller the skill score for a set number of forecasts. Also the smaller the set of forecasts, the more likely the standard will, by accident, be very good and hard to beat.
- Where two different skilled forecast techniques are applied to a representative set of data, the one yielding the larger positive score will be the more useful.
- The skill score is a good parameter for comparing forecasts from different climate regions.
- The skill score is primarily a summary score.

In summary, the skill score is sensitive to the climatological figure used in the calculation. However, it is an important indicator in the assessment of forecasting accuracy. The skill score can vary between plus and minus one. A score between zero and one indicates that forecasts are skillful relative to climatology.

E.7 THRESHOLD ANALYSIS

Threshold values are defined to establish operational requirements. For example, drilling operations may not operate in seas in excess of 5 metres significant height. Cranes may not operate above 40 knots. The Operator generally wants to know the accuracy of forecasts against agreed operational thresholds.

In the threshold analysis, forecast and observed values are allocated to one of four contingencies:

- Forecast correctly predicts that the threshold value is exceeded.
- Forecast correctly predicts that the threshold value is not exceeded.
- Forecast incorrectly predicts that the threshold value is exceeded (false alarm).
- Forecast incorrectly predicts that the threshold value is not exceeded (missed event).

The probability of detection, false alarm rate and missed event rate are obtained from a contingency table (Table 7-1). The aim is to achieve as high a probability of detection as possible while keeping the missed event and false alarm rates as low as possible. The false alarm rate equates to unnecessary cost, while the missed event rate has both cost and safety implications.

The threshold contingency table is given by Table 7-1.

Table 7-1 - Threshold Analysis Contingency Table

		Forecast (f)		
		Threshold exceeded	Threshold not exceeded	Totals
Observed (o)	Threshold exceeded	$T_{o>=t}^{f>=t}$	$T_{o>=t}^{f<t}$	$N_{o>=t}$
	Threshold not exceeded	$T_{o<t}^{f>=t}$	$T_{o<t}^{f<t}$	$N_{o<t}$
	Totals	$N_{f>=t}$	$N_{f<t}$	N_{total}

where:

o =Observed value.
f =Forecast value.
t =Threshold value.
$T_{o>=t}^{f>=t}$ =Number of times observed value exceeds threshold, and forecast value exceeds threshold.
$T_{o>=t}^{f<t}$ =Number of times observed value exceeds threshold, and forecast value does not exceed threshold.

$T_{o<t}^{f>=t}$ =Number of times observed value does not exceed threshold value, and forecast value exceeds threshold.

$T_{o<t}^{f<t}$ =Number of times observed value does not exceed threshold, and forecast value does not exceed threshold.

$N_{f>=t}$ =Number of times forecast exceeds threshold (and similarly for the other totals)

The following subsections describe useful threshold verification statistics.

E.7.1 Percent Correct

The percent correct (PC) is given by:

$$PC = \frac{T_{o>=t}^{f>=t} + T_{o<t}^{f<t}}{N_{total}} \times 100 \qquad \textbf{Equation 11}$$

The range of this statistic is zero to 100.

E.7.2 Probability of Detection

The probability of detection (POD) is a measure of the ability of the forecast program to successfully predict the "threshold exceeded" event.

The POD is given by:

$$POD = \frac{T_{o>=t}^{f>=t}}{N_{o>=t}} \qquad \textbf{Equation 12}$$

The range of this statistic is zero to 1.

E.7.3 False Alarm Rate

The false alarm rate (FAR) is a measure of the incorrect prediction of the "threshold exceeded" event.
The FAR is given by:

$$FAR = \frac{T_{o<t}^{f>=t}}{N_{o>=t}} \qquad \textbf{Equation 13}$$

The range of this statistic is zero to 1.

E.7.4 Missed Event Rate

The missed event rate (MER) is a measure of the incorrect prediction of the "threshold not exceeded" event.

The MER is given by:

$$MER = \frac{T^{f<t}_{o>=t}}{N_{o>=t}}$$ **Equation 14**

The range of this statistic is zero to 1.

E.8 SUMMARY

A verification system is recommended as a component of the forecast program. For the verification system to be an effective tool that: enables the Operator to gain confidence in the forecast program; and facilitates continuous improvement in the forecast and observing programs, then:

- observational errors should be evaluated and removed, where possible;
- observation and forecast parameters should be suitably matched;
- verification information should be updated in as near to real-time as possible; and,
- verification information should be presented to forecast-users in as near real-time as possible.

Appendix F

Ice Management Program

January 2004

ICE MANAGEMENT

The Ice Management Program is described in this section. Ice management is a required element of physical environmental programs for operations taking place in regions in which sea ice and/or icebergs can occur.

The Ice Management Program shall describe:

- ice detection,
- surveillance,
- data collection,
- reporting,
- forecasting, and
- avoidance or deflection.

Ice Management Plan

The Operator shall prepare and implement an ice management plan appropriate for the planned operations. Note that since ice conditions can vary greatly from area to area, and season-to-season, or year-to-year within an area, the ice management plan should be tailored to the region, period, and nature of the operation.

The ice management plan should be simple, functional, and provide guidance and a plan for action. The plan should address to some appropriate level of detail, the following critical factors:

Operations Plan and Operating Environment

- Operations details including any or all of: rig type, mode of station keeping, drilling season, well duration, re-supply plans, crew transport plans, etc.
- Description of physical environment conditions including sea ice, icebergs, marine climatology, physical oceanography, etc. The essential elements to describe are historical sea ice and iceberg conditions.

Ice Management Principles, Strategy, Approach

- corporate attitude towards ice management and toward risk acceptance
- strategy objectives should be defined, e.g.
    1- protection of crew and unit,
    2- allow operations with a minimum of disruption or added expense due to an ice situation.
- approach should be defined, e.g.
    1- iceberg monitoring (surveillance + observations + tracking + forecasts)
    2- ice alertness with zone definitions to determine response
    3- ice response: physical management such as towing and/or deflection; disconnect and departure from wellsite.

Regional Strategic Surveillance

- seasonal outlook
- zone of interest
- opportunistic surveillance
- dedicated surveillance
- remotely-sensed surveillance
- frequency of surveillance
- detectability/target verification
- time applicability

Local Tactical Surveillance and Observation

- aerial surveillance
- vessel-based surveillance
- rig-based surveillance
- detection
- ancillary information
- continuity
- roles/responsibilities

Reporting and Information Management

- reporting/recording tools
- level of automation
- quality control
- communications
- information dissemination
- data sharing

Determination of Risk

- incident command and control
- roles and responsibilities
- tactical ice forecasting
- definition of ice management response zones

Response

- safety considerations
- interaction with drilling operation
- roles and responsibilities
- physical ice management

Joint Ice Management

As part of ice management planning, the Operator should explore existing or potential synergies with other operators and ice service groups regarding joint ice management.

Potential practical benefits may exist in the areas of surveillance, observation, iceberg tracking, data sharing, tactical support, ice forecasting and trajectory modeling, and physical management.

Ice Reports

As part of, or in addition to, the reporting defined in the Ice Management Plan, the Operator shall report:

- ice messages coded as per MANMAR [5]
- iceberg messages coded as per MANICE [3] (i.e. in **ICEBERG** format)
- all relevant ice observation, reconnaissance, monitoring, and deflection reports to the Regulator in the event that ice enters the Installation's ice alert/response zones or in the event that the Operator undertakes an aerial reconnaissance for their area of interest. In these instances, daily reports to the Regulator as a minimum are required. Special reports shall be made to the Regulator when dictated by any significant events.

Appendix G

Contact Information

January 2004

Fisheries and Oceans Canada Contacts

Area	Address	Area Code	Phone Number	Fax Number
Canada	Director Marine Environmental Data Service Department of Fisheries and Oceans Suite 1202, 200 Kent Street Ottawa, Ontario, K1A 0E6	613	990-0264	990-5510
Atlantic	Regional Advisory Process Office Bedford Institute of Oceanography P.O. Box 1006 Dartmouth, Nova Scotia, B2Y 4A2	902	426-9920	426-5435
Québec	Director General Quebec Region Department of Fisheries and Oceans P. O. Box 15500 Quebec, Quebec, G1K 7Y7	418	648-4014	648-4470
Canada	Director, Hydrography Canada Centre for Inland Waters Bayfield Institute 867 Lakeshore Road P.O. Box 5050 Burlington, Ontario, L7R 4A6	905	336-4811	336-8916
Pacific and Arctic	Chief, Data Assessment Division Institute of Ocean Sciences P. O. Box 6000 Sidney, British Columbia, V8L 4B2	604	363-6335	363-6479

Environment Canada Contacts

Area	Address	Area Code	Phone Number	Fax Number
Canada	Assistant Deputy Minister Meteorological Service of Canada 4905 Dufferin Street Downsview, Ontario, M3H 5T4	819 416	997-2686 739-4770	739-4232
Canada	Director General Atmospheric Monitoring and Water Survey Directorate Meteorological Service of Canada 4905 Dufferin Street Downsview, Ontario, M3H 5T4	416	739-4965	739-4261
Atlantic	Regional Director General Environment Canada, Atlantic Region 15th Floor, Queen Square 45 Alderney Drive Dartmouth, Nova Scotia, B2Y 2N6	902	426-6700	426-2690
Atlantic	Regional Director Meteorological Service of Canada, Atlantic Region 16th Floor, Queen Square 45 Alderney Drive	902	426 9120	426 3256

Area	Address	Area Code	Phone Number	Fax Number
	Dartmouth, Nova Scotia, B2Y 2N6			
Québec	Directeur général régional Environment Canada, La région du Québec 1141 rue de l'Eglise Sainte-Foy, Quebec, G1V 4H5	418	648-4077	649-6213
Ontario	Regional Director General Environment Canada, Ontario Region 4905 Dufferin St. Downsview, ON M3H 5T4	416	739-4666	739-4691
Prairie and Northern	Regional Director General Environment Canada, Prairie and Northern Region Twin Atria Building 4999 - 98 Avenue, 2nd Floor Edmonton, Alberta, T6B 2X3	780	951-8869	495-3086
Pacific and Yukon	Regional Director General Environment Canada, Pacific and Yukon Region 201 – 401 Burrard St. Vancouver, British Columbia, V6C 3S5	604	664-9145	664-9190
Canada	Canadian Ice Services Meteorological Service of Canada 373 Sussex Drive La Salle Academy, Block E Ottawa, Ontario, K1A 0H3	613	996-5088	996-4218
Canada	Ice Operations Meteorological Service of Canada 373 Sussex Drive La Salle Academy, Block E Ottawa, Ontario, K1A 0H3	613	996-4552	996-4218

Transport Canada Contacts

Area	Address	Area Code	Phone Number	Fax Number
Atlantic	Regional Superintendent Air Carriers Operations Transport Canada P.O. Box 42 Moncton, New Brunswick, E1C 8K6	506	851-7249	851-7190
Beaufort Sea	Regional Superintendent Air Carriers Operations Transport Canada Suite 1100, Canada Place 9700 Jasper Avenue Edmonton, Alberta, T5J 4E6	403	495-3868	495-4622
Eastern Hudson Bay	Regional Superintendent Air Carriers Operations Transport Canada Suite 300, 4900 Younge Street Willowdale, Ontario, M2N 6A5	416	224-3765	224-4711
Western	Regional Superintendent	204	983-1409	983-1734

Area	Address	Area Code	Phone Number	Fax Number
Hudson Bay	Air Carriers Operations Transport Canada P. O. Box 8550 333 Main Street Winnipeg, Manitoba, R3C 0P6			
Québec	Regional Director Air Carriers Operation (NAX) Transport Canada 700 rue Leig	514	633-2836	633-3697

Industry Contacts

Area	Address	Area Code	Phone Number	Fax Number
Canada	Canadian Association of Petroleum Producers (CAPP) 2100, 350 - 7 Avenue SW Calgary, AB, T2P 3N9	403	267-1100	261-4622
Nova Scotia	Canadian Association of Petroleum Producers (CAPP) Suite 230, 1801 Hollis Street, Halifax, NS, B3J 3N4	902	420-9084	491-2980
Newfoundland	Canadian Association of Petroleum Producers (CAPP) 235 Water Street, Suite 905 St. John's, NF, A1C 1B6	709	724-4200	724-4225

Regulator Contacts

Area	Address	Area Code	Phone Number	Fax Number
Canada	National Energy Board 444 Seventh Avenue SW Calgary, AB, T2P 0X8	403	292-4800	292-5503
Nova Scotia	Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) 1791 Barrington Street Halifax, NS, B3J 3K9	902	422-5588	422-1799
Newfoundland	Canada-Newfoundland Offshore Petroleum Board (CNOPB) 140 Water Street St. John's, NF, A1C 6H6	709	778-1400	778-1473

Appendix H

METADATA REPORT FORMAT

January 2004

Metadata Reporting Format under development January 2004

Date of report (YYYY,MM,DD)	
Name of agency which prepared report	
Contact information for agency which prepared the report.	
Rig or platform name	
MANMAR call sign	
METAR call sign	
Are METAR observations official or for internal use?	
Type of rig or platform	
Type of program (e.g. exploration, development, production)	
Latitude	
Longitude	
Location name	
Water depth	
Times of standard MANMAR observations	
Times of standard METAR observations	
Fields observed in MANMAR reports	
• Wind direction	
• Wind speed	
• Mean sea level pressure	
• Pressure tendency	
• Pressure tendency characteristic	
• air temperature	
• air humidity (dew point and wet bulb temperature)	
• horizontal visibility	
• cloud and ceiling heights	
• cloud layer amounts	
• cloud layer opacities	
• cloud types	
• vertical visibility	
• precipitation intensity	
• precipitation amount	
• current weather types	
• past weather types	
• height of anemometer	
• height of barometer	
• reference height of station	
• sea wave significant height	
• sea wave direction	
• sea wave average period	
• swell direction(s)	
• swell significant height(s)	
• swell average period(s)	
• maximum combined significant wave height	
• wave spectrum peak period	
• sea surface temperature	
• ice accretion rate	
• ice accretion amount	
• ice / iceberg conditions	
Fields observed in METAR reports	
• Wind direction	
• Wind speed	

• Mean sea level pressure	
• Pressure tendency	
• Altimeter setting	
• air temperature	
• air humidity (dew point and wet bulb temperature)	
• horizontal visibility	
• cloud and ceiling heights	
• cloud layer amounts	
• cloud layer opacities	
• cloud types	
• vertical visibility	
• precipitation intensity	
• current weather types	
• past weather types	
• height of anemometer	
• height of barometer	
• reference height of station	
• heave, pitch and roll	
• maximum combined significant wave height	
• sea surface temperature	
Height of anemometer used for weather observations (ASL)	
Height of alternate anemometer (ASL)	
Is the wind speed adjusted to a given reference level such as 10 metres?	
• If so, what method is used (log profile formula or power law formula)?	
Length of averaging period for mean wind speed	
Wind speed averaging method (scalar or vector mean)	
Barometer height (ASL)	
Thermometer height (ASL)	
Method/instrument used to measure Sea Surface Temperature	
Wave observations - method and/or instruments used (e.g. nearby waverider, downward looking laser, radar, visual estimate, or combination), and length of sampling period	
If wave observations reported, equivalent meta-data information for any reported field that comes from a nearby support vessel	
Current observations – instrument type	